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SOD SEEDING OF FORAGES
II. Vegetation Control

by

G.W. Mueller-Warrant, D.W. Koch, and J.R. Mitchell

NEW HAMPSHIRE
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEW HAMPSHIRE
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ABSTRACT

One of the most important management decisions in planning a sod seeding is the method of controlling vegetation. This report highlights the results of a number of no-till seedings of alfalfa into sod at several locations in southern New Hampshire from 1977 to 1980. Various herbicides, application dates, and rates were studied in relation to seeding dates. Only fields with soil sufficiently fertile for alfalfa production were selected for renovation.

Most consistent and effective control of grasses and broadleaf weeds was achieved with spring application of glyphosate. A glyphosate treatment in early May was superior to an application in mid-late May, measured in terms of seedling density and first harvest forage and alfalfa yield. Fall treatment with glyphosate gave adequate sod control when vegetation was green and actively growing at time of treatment. Pronamide was useful in controlling perennial grasses and was most effective when three lbs/acre or more were applied in the fall. It did not control broadleaf weeds. Treatment with pronamide in the fall, followed by paraquat at time of seeding, improved alfalfa establishment over that from either herbicide alone. Paraquat provided adequate suppression of vegetation only with split fall and spring or split application in the spring.

Existing (old) alfalfa was more easily controlled with glyphosate when it was 10-12 inches in height (mid-May) than earlier. When seeding was within a few days after treatment, establishment generally improved with glyphosate rate up to 2.0 lbs/acre; 1.33 lbs/acre was adequate if applied at least two to three weeks before sod seeding.

Delaying application of glyphosate until near seeding time resulted in decreased seedling density and decreased alfalfa yields, in most cases. Alfalfa was most adversely affected by seeding immediately after herbicide treatment on moderately well-drained and poorly drained soils. On extremely well-drained (sandy) soils, alfalfa seeded soon after treatment with glyphosate established as well as when treated earlier.

KEY WORDS: No Till seeding, Reduced tillage, Alfalfa establishment, Glyphosate, Pronamide, Paraquat, 2,4-D, Seeding date, Quackgrass control.

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SOD SEEDING OF FORAGES. II. VEGETATION CONTROL

G. W. Mueller-Warrant, D. W. Koch, and J. R. Mitchell[1/]

INTRODUCTION

With the recent development of new herbicides and no-tillage seeding equipment there is an opportunity for timely introduction of legumes in order to sustain high productivity of hay land and pastures. Alfalfa is the most productive legume in the Northeast when grown on soils which are well drained and highly fertile. It is often used as a comparatively inexpensive source of home-grown protein for dairy animals. While alfalfa is a relatively long-lived crop, periodic renovation of stands is necessary to maintain maximum yields and quality. Much of the land in forage production in the Northeast is rocky and/or steep. Difficulties in renovating and delayed re-seeding lead to alfalfa thinning and grass domination of the stand.

One alternative to complete renovation is application of nitrogen; however, the currently high cost of nitrogen and the relative unresponsiveness of weedy grasses limit the value of this method. There is a need for reliable methods of introducing legumes without tillage.

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LITERATURE REVIEW

Van Keuren and Triplett (21) noted that it is necessary to reduce grass competition with herbicides during no-till establishment of alfalfa seedlings. Other researchers have made successful no-till seedings of alfalfa without herbicides, but have found it necessary to reduce grass competition by repeated clipping of the grass just above the legume seedlings (19).

Paraquat at 0.25 to 0.5 lbs/acre has been widely used to desiccate and destroy emerged vegetation prior to no-till seeding of many crops (20). Paraquat is most effective on sods dominated by the less vigorous species, such as Kentucky bluegrass, timothy, and red fescue (22).

Grasses can be controlled with pronamide at rates of 2 to 3 lbs/acre. Pronamide is absorbed entirely through the root system and is subject to chemical degradation in the soil at temperatures above 50F (16). It is therefore most effective if applied in late fall and moved into the soil by rainfall before the ground freezes.

Glyphosate provides nearly complete kill of most herbaceous perennial species at rates of 1.0 to 3.0 lbs/acre when applied to the foliage and translocated throughout the plant during periods of active growth (1,17). Quackgrass in the spring is not adequately controlled by glyphosate until the three- to four-leaf stage (6 inches), when the quackgrass shoot directs most of its carbohydrates to the rhizomes. Under these conditions glyphosate will destroy the regenerative potential of rhizome nodes (15). Previous research (3,10,18) has shown some advantage in delaying seeding as much as one month following glyphosate application. Delayed seeding, compared to seeding immediately after treatment, was associated with: (1) more alfalfa seedlings per ft^2, (2) faster development of alfalfa seedlings, (3) greater alfalfa yield at the first harvest, and (4) greater density of alfalfa plants the year after seeding. Following the application of

glyphosate, Moshier and Penner (9) noticed injury to seedlings when the decaying vegetation collapsed onto them. Both Moshier and Penner (9) and Campbell (3) found negative effects of glyphosate on establishment of sod-seeded alfalfa when application rate increased beyond 2.0 lbs/acre and when treatment and seeding dates were in close proximity. They felt that emerging alfalfa seedlings might be absorbing glyphosate through contact with treated litter on the soil surface. However, glyphosate applied at rates as high as 60 lbs/acre to the soil has not been found toxic to plants (1).

Successful establishment of alfalfa is favored by a minimum of competition from weeds or companion small grains during the late spring and early summer, especially if moisture is limiting (11). Taylor et al. (19) found that minimum-tillage seedings in the spring were more often successful than late-summer seedings, which were superior to mid-summer seedings.

METHODS AND MATERIALS

Sod seedings of 'Saranac' alfalfa at 12 lbs/acre were made in 1977-79 at the locations shown in Table 1. In 1978 and in 1979 a [1]John Deere Powrtill seeder was used to seed into vegetation mowed to a 2-inch stubble height after herbicide treatment. A [1]Tye Pasture Pleaser seeder was used for the 1979 seedings in vegetation left in place after herbicide treatment. Herbicides evaluated included pronamide [3,5-dichloro (N-1,1-dimeyhyl-2-propnyl benzamide], paraquat (1,1'-dimethyl-4,4'-bipyridinium ion), glyphosate [N-(phosphonomethyl) glycine], and 2,4-dichlorophenoxy acetic acid. Carbofuran (2,3-dihydro-2,2'-dimethyl-7-benzofuranyl methyl carbamate) was broadcast at 1.0 lb/acre to all seedings soon after alfalfa seedling emergence. All treatments were replicated from 3 to 5 times.

All fields renovated had previously been seeded conventionally to alfalfa. Stands had eventually become dominated by various cool-season grasses. All sites had pH values between 5.7 and 6.4 and medium to very high levels of available phosphorus (Table 1). Phosphorus was surface applied prior to no-till seeding to raise the soil test response of the surface 4 inches to very high levels. Potassium was applied in accordance with expected crop removal the year following seeding.

Seedlings were counted 3 to 7 weeks after seeding in randomly chosen 1 ft^2 areas within each plot. Swaths 3 ft wide across each plot were harvested and weighed, and subsampled in order to determine percentage dry matter. Species composition of forage was determined by hand separation of subsamples in 1977, and was visually estimated for all harvests taken from 1978 to 1980. Percentage ground cover by alfalfa was visually estimated at three to four weeks after harvest during the year following seeding.

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[1]Mention of a commercially available product is for the benefit of the reader and does not imply endorsement by the New Hampshire Agricultural Experimental Station.

Table 1. Descriptions of fields used in no-till alfalfa studies.

Location	Cooperator	Soil			[a]Species present prior to treatment, %						
		Series	pH	P[b]	ALF	QG	SBG	OR	TI	KBG	BW
Madbury	Univ. N.H.	Charlton	6.2	VH	0	90	0	0	0	5	5
Lee	R. Booth	Hollis	5.7	H	0	5	0	65	0	10	20
Pembroke	Richard Bros.	Merrimac	6.1	VH	65	20	0	0	0	0	15
Lee	Univ. N.H.	Charlton	6.4	L-M	45	25	25	0	0	5	0
Epsom	R. Yeaton	Hinckley	6.2	H	20	20	60	0	0	0	0
Pittsfield	D. Osborne	Paxton	6.6	H	0	5	10	25	20	25	10
Northwood	S. Johnson	Paxton	6.1	M	0	15	10	0	20	15	35

[a]ALF = alfalfa, QG = quackgrass, SBG = smooth bromegrass, OR = orchardgrass, TI = timothy, KBG = Kentucky bluegrass, and BW = broadleaf weeds. Sward composition was judged in the fall of the year in which treatments were initiated.

[b]L,M,H,VH denote low, medium, high and very high levels, respectively, of soil available phosphorus (P).

RESULTS AND DISCUSSION

Control of grasses

As shown in Table 1, all stands except the one at Pembroke, were dominated by grasses. Quackgrass, bromegrass, and orchardgrass were the most aggressive species present. At all locations at least one of these species was present in significant amounts when the experiments were initiated.

The response to fall-applied glyphosate at various rates is shown in Table 2. Good control of grasses was obtained when glyphosate was applied at 1.0 to 3.0 lbs/acre to green growth at least five inches high.

At Northwood, dry weather in late summer-early fall of 1978, in combination with the low soil fertility, caused the grasses to be yellow and brown in color in September and October. Grasses in this condition were unaffected by glyphosate, even at the highest rate used. At Epsom, the field had been closely grazed in September of 1978. Glyphosate at 2.5 lbs/acre was needed for 50% control of grasses on October 23, whereas on November 13, when the grass had reached 4-5 inches, only 1.1 lbs/acre of glyphosate was needed for comparable grass control. This is evidence that previous management and soil conditions can affect response to glyphosate.

The rate of fall-applied glyphosate necessary to provide good control of grasses varied with site and year, probably due to differences in translocation of the herbicide from the leaves into the root system, which would be influenced by amount of leaf area present and the photosynthetic activity of leaves. Control of healthy cool-season grasses has been reported to improve slightly when glyphosate was applied immediately following a light frost (4).

The effectiveness of pronamide was influenced more by rate of application than by condition of grasses at time of treatment (Table 3). This is expected since pronamide enters plants through the roots only (16). Pronamide at 3.0 lbs/acre was needed to adequately control vigorous

Table 2. Grass control and alfalfa establishment from fall-applied glyphosate at seven locations.

Grass condition	Rate of glyphosate	Grass control	Alfalfa content, first harvest
	lbs/acre	%	
Yellow-green to green, more than 5 inches growth	0.6 to 1.0	62	62
	1.2 to 1.6	65	62
	1.9 to 2.3	85	73
	2.5 to 3.1	82	69
[a]Green with less than 4 inches growth	0.6 to 1.0	1	24
	1.2 to 1.6	0	29
	1.9 to 2.3	25	44
	2.5 to 3.1	58	57
[b]Yellow to brown	0.6 to 1.0	0	2
	1.2 to 1.6	4	3
	1.9 to 2.3	3	8
	2.5 to 3.1	10	12

[a]Seedings were made on April 25 and May 3 at Epsom. Grass was extremely short when treated in the fall due to grazing in September.

[b]Sod at Northwood was subject to late summer drought. Seeding made on May 28.

grasses such as quackgrass, bromegrass, and orchardgrass. The addition of paraquat at time of seeding to pronamide treatment the previous fall was a reliable method for establishing alfalfa although, in some instances, it was slightly less satisfactory than spring-applied glyphosate.

Glyphosate applied in the spring generally controlled grasses better than when applied in the fall at equal rates (Tables 2 and 4). Control of grasses improved, at all locations, with increases in glyphosate rates from 0.7 to 1.3 lbs/acre (Table 4). At some locations, grass control improved with increases in glyphosate rates from 1.3 to 2.0

Table 3. Grass control and alfalfa establishment with pronamide and paraquat at seven locations.[a]

Treatment		Grass control	Alfalfa content, first harvest
Herbicide	Rate		
	lbs/acre	%	
Pronamide	1.0	33	38
Pronamide	2.0 - 2.2	64	59
Pronamide	3.0 - 3.3	86	71
Pronamide +Paraquat	2.0 - 2.2 0.25 - 0.50	86	78

[a]Grasses were yellow-green to green and at least 5 inches high when treated. Ten seedings were made at five different locations.

Table 4. Responses to spring-applied herbicides at seven locations.

Treatment		Grass percentage, first harvest		Alfalfa percentage, spring following seeding	
Herbicide	Rate	Avg.	Range	Avg.	Range
	lbs/acre				
Glyphosate	0.7 to 1.0	42	28 - 56	57	45 - 68
Glyphosate	1.3 to 1.5	24	9 - 38	68	57 - 79
Glyphosate	2.0	12	5 - 20	82	73 - 91
Glyphosate	2.7	18	7 - 29	73	65 - 80
Paraquat	0.5	70	55 - 84	54	35 - 72
Split paraquat	0.25 + 0.25	54	39 - 69	47	34 - 60
Pronamide (fall) + Paraquat (spring)	2.0 0.25	17	7 - 26	73	64 - 82

lbs/acre. Even 0.7 lbs/acre was often sufficient to cause injury to nearly all grass topgrowth. However, considerable regeneration from underground growing points occurred at rates under 1.0 lbs/acre. The somewhat better grass control obtained with 2.0 lbs/acre of glyphosate generally did not improve alfalfa establishment over that from rates of 1.3 to 1.5 lbs/acre, although it did slightly increase the ratio of

alfalfa to grass in the stand. Substantial variation with location occurred in response to spring-applied herbicides (Table 4). Grass percentage of forage at the first harvest varied by a factor of four times with glyphosate rates between 1.3 and 1.5 lbs/acre.

Successful establishment of alfalfa was more consistently obtained with glyphosate than with paraquat. On average, paraquat resulted in establishment of an alfalfa percentage similar to that from 0.7 lbs/acre of glyphosate (Table 4). Split application of paraquat was more effective than single application on quackgrass and orchardgrass. Paraquat was also effective as a followup treatment of plants recovering from pronamide treatment, or to temporarily suppress, without sacrificing desirable species such as alfalfa.

Control of existing alfalfa

At Pembroke, where there was a relatively dense stand of alfalfa, an attempt was made to maintain existing (old) alfalfa plants, yet enhance establishment of new alfalfa seedlings by reducing grass and weed pressure. Pronamide, applied in the fall, killed grasses and left old alfalfa plants unharmed, but few new alfalfa plants established (Table 5). Treating with 2,4-D, followed with pronamide, injured or killed much of the old alfalfa, as well as controlling grasses, but relatively little alfalfa was established. Glyphosate applied November 16 had a similar effect. At that time alfalfa had gone dormant, as indicated by drooping stems and yellow and white leaves. Glyphosate applied November 1, however, controlled nearly all of the old alfalfa. It was the only treatment with a significant amount of newly established alfalfa and with which alfalfa stands were improved over those initially present.

At Lee (University of New Hampshire) fall-applied glyphosate did not affect the existing alfalfa, which appeared to be dormant at time of treatment (Table 6). Old alfalfa at Lee survived treatment with 0.7 lbs/acre of glyphosate on May 2. Higher rates of glyphosate were required to control old alfalfa on May 2 than on May 16. Apparently, translocation patterns were more favorable, at this location, in mid-May.

Table 5. Control of existing alfalfa with fall-applied herbicides and establishment of new alfalfa with spring sod seeding at Pembroke.[a]

Treatment			Alfalfa percentage, first harvest		Alfalfa ground cover, 1980
Herbicide	Date	Rate	Old	New	
		lbs/acre			%
Glyphosate	Nov. 1	2.0	10 c	47 a	79 a
Glyphosate	Nov. 16	2.0	52 b	10 b	54 b
Pronamide	Nov. 16	2.0	85 a	1 c	46 b
2,4-D + Pronamide	Nov. 1 Nov. 16	1.4 2.0	43 b	9 b	45 b

[a]Means followed by the same letter within a column for a single location do not differ at the 5% level.

Table 6. Control of existing alfalfa with herbicides and establishment of new alfalfa with spring sod seeding at Lee (University of New Hampshire).[a]

Treatment			Alfalfa percentage, first harvest		Alfalfa ground cover, 1980
Herbicide	Date	Rate	Old	New	
		lbs/acre			%
Glyphosate	Oct. 28	2.0	84 a	10 c	50 cde
Pronamide	Nov. 17	3.0	81 a	8 c	58 bcd
Glyphosate	May 2	0.7	28 c	35 b	48 de
Glyphosate	May 2	1.3	4 d	81 a	60 bc
Glyphosate	May 16	0.7	0 e	45 b	43 e
Glyphosate + Glyphosate	Oct. 28 May 2	1.3 0.7	56 b	37 b	64 ab
Glyphosate + Glyphosate	Oct. 28 May 16	1.3 0.7	2 de	91 a	79 a

[a]Means followed by the same letter within a column do not differ at the 5% level.

Control of Broadleaf Weeds

At locations with perennial broadleaf weeds, 2,4-D and/or dicamba (3,6-dichloro-o-anisic acid) was applied early in the fall preceding the planned no-till seeding.

Broadleaf weed control from these herbicides was usually very satisfactory, however, at Northwood, where dandelions were abundant, 2,4-D + dicamba applied in the fall before seeding failed to provide control due to weed dormancy at time of treatment. This was probably induced by the cool, dry weather and the relatively low soil fertility. These herbicides can also be applied in the spring, allowing 3 to 4 weeks for deactivation in the soil before seeding. While application of 2,4-D one day after seeding gave better control of dandelions than did application of paraquat, 2,4-D was excessively toxic to alfalfa seedlings (Table 7).

At Pittsfield, the judgment that the number of broadleaf weeds were insufficient to justify application of 2,4-D in the fall proved to be in error. On plots treated in the fall with grass-killing herbicides, such as pronamide and glyphosate, dense growth of perennial broadleaf weeds occurred. Glyphosate, applied in the spring, however, gave excellent control of these weeds.

Table 7. Effects of spring-applied 2,4-D and paraquat on a 1979 sod seeding of alfalfa at Northwood, N.H.

Herbicide	Alfalfa seedling density	Dandelion yield, Oct. 22	Alfalfa yield, spring following seeding
	No./ft^2	lbs/acre	tons/acre
Paraquat	6.7	304	0.96
2,4-D	2.7	232	0.49
LSD (.05)	2.0	62	0.32

Timing of herbicide treatment in relation to seeding

Glyphosate applied in early May and followed by a mid to late-May seeding resulted in highest seedling densities and alfalfa yields in 1979 (Tables 8 and 9). Treatment just prior to seeding in late May was much less suitable. In all seedings made from 1977 to 1980 treatment early in May with seeding delayed 2-3 weeks resulted in higher yields of alfalfa the first harvest than did treatment later in May with the same seeding date (Table 9). First harvest yields of seedings made in 1979 were lower than those in 1977 due to a virtual lack of rainfall from early June through July. The best alfalfa ground cover ratings were obtained with the combination of early treatment and mid-to late-May seeding (Table 10). By the second year, however, there was little difference among treatment date/seeding date combinations in alfalfa yield. These results are in agreement with previous research results, which indicate that there is an advantage to delayed seeding following glyphosate application (3,10,18).

Table 8. Effects of glyphosate application and seeding dates on alfalfa seedling density at four locations.[a]

Glyphosate applications	Seeding date	Alfalfa seedling density by location[b]			
		Madbury	Lee	Pittsfield	Northwood
		no./ft^2			
Fall	Early May	x	6.3 bc	12.7 b	x
Fall	Mid- late May	x	14.2 a	16.4 a	4.5 b
Early May	Early May	29.0 a	4.2 c	8.6 c	x
Early May	Mid- late May	27.9 a	12.4 a	15.7 a	6.1 a
Mid- late May	Mid- late May	15.6 b	8.2 b	14.2 ab	2.2 c

[a]Means followed by the same letter within a column do not differ at the 5% level.

[b]Seedling counts were made one month after seeding and are averaged over glyphosate rates of 1.3, 2.0, and 2.7 lbs/acre, except at Madbury, which received only 2.0 lbs/acre.

Table 9. Effect of seeding date in relation to glyphosate application on first-harvest yield of alfalfa at four locations.[a]

Glyphosate application	Seeding date	Alfalfa yield by location[b]			
		Madbury	Lee	Pittsfield	Northwood
		tons/acre			
Fall	Early May	x	0.17 cd	0.41 bc	x
Fall	Mid- late May	x	0.10 d	0.30 c	0.00 c
Early May	Early May	1.10 a	0.26 b	0.38 bc	x
Early May	Mid- late May	0.90 a	0.39 a	0.54 a	0.16 a
Mid- late May	Mid- late May	0.64 b	0.22 bc	0.44 b	0.06 b

[a]Means followed by the same letter within a column do not differ at the 5% level.

[b]Alfalfa yields are for the first harvest and are averaged over glyphosate rates of 1.3, 2.0, and 2.7 lbs/acre, except at Madbury, which received only 2.0 lbs/acre.

Table 10. Effect of seeding date in relation to glyphosate application on ground cover ratings of alfalfa at four locations.[a]

Glyphosate application	Seeding date	Alfalfa ground cover by location[b]			
		Madbury	Lee	Pittsfield	Northwood
		% ground cover			
Fall	Early May	x	53 bc	69 b	x
Fall	Mid- late May	x	49 c	69 b	5 c
Early May	Early May	100 a	48 c	93 b	x
Early May	Mid- late May	95 ab	67 a	86 a	43 a
Mid- late May	Mid- late May	80 b	62 ab	82 ab	14 b

[a]Means followed by the same letter within a column do not differ at the 5% level

[b]Ratings of alfalfa ground cover were made three to four weeks following harvest during the seeding year and are averaged over glyphosate rates of 1.3, 2.0, and 2.7 lbs/acre, except at Madbury, which received only 2.0 lbs/acre.

Fall application of glyphosate generally resulted in similar or higher seedling densities than those from spring treatments (Table 8). With fall-applied herbicides, establishment and first-harvest yields were usually better with an earlier, compared with a later, spring seeding date (Tables 8-10). This was due, in part, to the effects of competition from the surviving species on alfalfa seedlings. Seedlings would obviously be smaller and more vulnerable to competition if seeded later in the spring since the surviving weeds will begin spring growth without regard to the date the alfalfa was seeded. Fall-applied glyphosate with a followup application in late May, 1980, produced a stand better than that from any other treatment at Lee (79% ground cover rating, vs. 67% gound cover for the next best treatment). Baird, et al. (1) reported superior control of quackgrass when a given amount of glyphosate was split-applied between the fall and spring, rather than in one application.

The advantage of delaying seeding following spring treatment must be weighed against the likelihood that later seedings will encounter summer dry periods, having had less time for seedlings to develop root systems. An advantage of sod seeding, however, is that once the sod is killed and left in place, moisture is effectively conserved, in contrast to conventionally prepared seedbeds. This may allow for later spring planting with sod seeding, compared with conventional seeding. Also, by delaying spring seeding, surviving fall treatment and early germinating annual weeds can be more effectively controlled. Early seeding in the spring, made possible by fall application of herbicides would likely be most beneficial on sandy, droughty soils.

Comparative results of an August and a late spring no-till seeding in 1977 are shown in Table 11. The August seeding in 1977 received less than 0.4 inches of rainfall during the first two weeks after seeding. in contrast to 1.7 inches for the June 4 seeding. Under conditions as dry as those encountered by the August seeding, the value of glyphosate in preventing moisture depletion by the sod is clearly evident. However,

since treating with glyphosate on May 30 and waiting until August to seed would sacrifice forage production during the seeding year, such a program seems impractical.

Table 11. Comparison of August and late spring no-till seeding of alfalfa into dense quackgrass.[a]

Treatment		Seeding	Alfalfa content,	Seasonal yields[b]		Alfalfa standing rating[c]
Herbicide	Date	date	spring harvest	Forage	Alfalfa	
			%	— tons/acre —		% optimum
Paraquat	Aug. 8	Aug. 9	3 d	1.6 c	0.1 c	3 d
Glyphosate	May 30	Aug. 9	49 b	2.9 b	1.8 b	67 b
Paraquat	June 3	June 4	27 c	2.4 b	1.3 b	47 c
Glyphosate	May 30	June 4	97 a	4.0 a	3.9 a	93 a

[a]Means followed by the same letter within a column do not differ at the 5% level.

[b]Total for the year following establishment.

[c]Based on visual ratings by two observers on alfalfa ground cover and vigor two weeks following last seasonal harvest.

CONCLUSIONS

1. Suppression of such vigorous grasses as quackgrass, bromegrass, and orchardgrass was vital to successful establishment of no-till alfalfa.

2. Spring application of glyphosate consistently controlled existing vegetation, while fall application produced variable results.

3. Other successful methods for suppressing vegetation included: (a) split application of paraquat fall and spring or split application in the spring; (b) fall application of pronamide followed at time of seeding by paraquat or a low rate of glyphosate; and (c) fall application of glyphosate to green, healthy-looking vegetation.

4. Increased seedling numbers and increased yield of alfalfa at first harvest were achieved by killing vegetation two or more weeks in advance of seeding, compared with treatment just before seeding, especially on moderately well-drained and poorly-drained soils.

5. The optimum rates of glyphosate were: (1) approximately 1.33 lbs/acre in early May for delayed seeding; (2) 2.0 lbs/acre immediately before seeding; and (3) 1.5 to 2.0 lbs/acre in the fall for early spring seeding.

6. Fall application of glyphosate at 1.0 to 1.5 lbs/acre resulted in a well decomposed sod at time of spring seeding. Following this application with a treatment of 0.5 to 1.0 lbs/acre glyphosate just prior to seeding in mid- late May (when shoots of surviving grass plants were emerged) improved stands of alfalfa.

REFERENCES

1. Baird, D.D., R.P. Upchurch, W.B. Homesly, and J.E. Franz. 1971. Introduction of a new broadspectrum postemergence herbicide class with utility for herbaceous perennial weed control. Proc. North Central Weed Control Conf. 26: 64-68.

2. Blevins, R.I., L.W. Murdock, and G.W. Thomas. 1978. Effects of lime application on no-tillage and conventionally tilled corn. Agron. J. 70: 322-326.

3. Campbell, M.H. 1974. Effects of glyphosate on the germination and establishment of surface-sown pasture species. Aust. J. Exp. Agric. Anim. Husb. 14:557-560.

4. Davis, H.E., R.S. Fawcett, and R.G. Harvey. 1978. Effect of fall frost on the activity of glyphosate on alfalfa (Medicago sativa) and quackgrass (Agropyron repens). Weed Sci. 26: 41-45.

5. Dowling, P.M., and D.L. Linscott. 1981. Effects of chemicals on the establishment of direct planted alfalfa. Proc. Northeastern Weed Sci. Soc. 35: 42-43.

6. Hodgson, J.M. 1974. Quackgrass control and crop production with herbicides. Proc. Western Soc. Weed Sci. 27: 17-19.

7. Kalmbacher, R.S., D.R. Minnick, and F.G. Martin. 1979. Destruction of sod-seeded legume seedlings by the snail (Polygyra cereolus). Agron. J. 71: 365-368.

8. Linscott, D.L., F.D. Hagin, R.R. Seany, and R. Burt. 1973. Seedling crownvetch growth on hill slopes after glyphosate treatments (1972); A progress report. Proc. Northeastern Weed Sci. Soc. 27: 9-12.

9. Moshier, L. and D. Penner. 1978. Use of glyphosate in sod seeding alfalfa (Medicago sativa) establishment. Weed Sci. 26: 163-166.

10. Mueller-Warrant, G.W. and D.W. Koch. 1980. Establishment of alfalfa by conventional and minimum-tillage seeding techniques in a quackgrass-dominant sward. Agron. J. 72: 884-889.

11. Peters, R.A. 1961. Legume establishment as related to the presence or absence of an oat companion crop. Agron. J. 53: 195-198.

12. Peters, R.A. 1979. Competition between seedling alfalfa and crabgrass as influenced by herbicide treatments. Proc. Northeastern Weed Sci. Soc. 33: 20-23.

13. Peters, R.A. and J. Zaprzalka. 1981. Impact of Furadan treatment on no-tillage alfalfa establishment. Proc. Northeastern Weed Sci. Soc. 35: 76.

14. Rayburn, E.B., F.J. Hunt, and D.L. Linscott. 1981. Three year summary of no-till forage establishment research on New York farm sites. Proc. Northeastern Weed Sci. Soc. 35: 65-66.

15. Rioux, R., J.D. Bandeen, and G.W. Anderson. 1974. Effects of growth stage on translocation of glyphosate in quack grass. Can. J. Plant Sci. 54: 397-401.

16. Smith, L.W., R.I. Peterson, and R.R. Horton. 1971. Effects of a dimethylpropynyl benzamide herbicide on quackgrass rhizomes. Weed Sci. 19: 174-177.

17. Sprankle, P., W.F. Meggitt, and D. Penner. 1974. Absorption, action, and translocation of glyphosate. Weed Sci. 23: 235-240.

18. Stewart, V. and I. Welty. 1980. Crop management: Researchers renovated pastures in one year. Crops and Soils Magazine 32(5): 22.

19. Taylor, T.H., E.M. Smith, and W.C. Templeton, Jr. 1969. Use of minimum tillage and herbicides for establishing legumes in Kentucky bluegrass (Poa pratensis L.). Agron. J. 61: 761-766.

20. Triplett, G.B., Jr., R.W. Van Keuren, and V.H. Watson. 1975. The role of herbicides in pasture renovation. In Proc. 1975 No Tillage Forage Symposium. The Ohio State University and OARDC.

21. Van Keuren, R.W. and G.B. Triplett. 1970. Seeding legumes into established grass swards. Proc. 11th Int. Grassl. Cong. p. 131-134.

22. Warboys, I.B. 1967. Improvement of permanent pasture by over-drilling and oversowing. II. Pasture establishment by oversowing. Exp. Agric. 3: 63-77.

23. West, C.P., N.P. Martin, and G.C. Marten. 1980. Nitrogen and rhizobium effects of establishment of legumes via strip tillage. Agron. J. 72: 620-624.